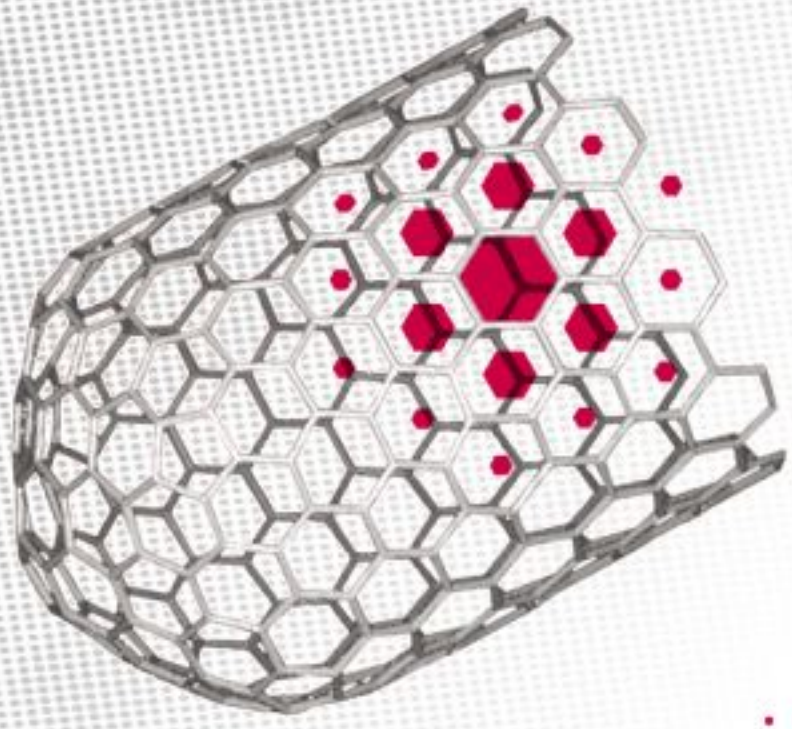


BrainsUnite part II

How do we get to something that works?

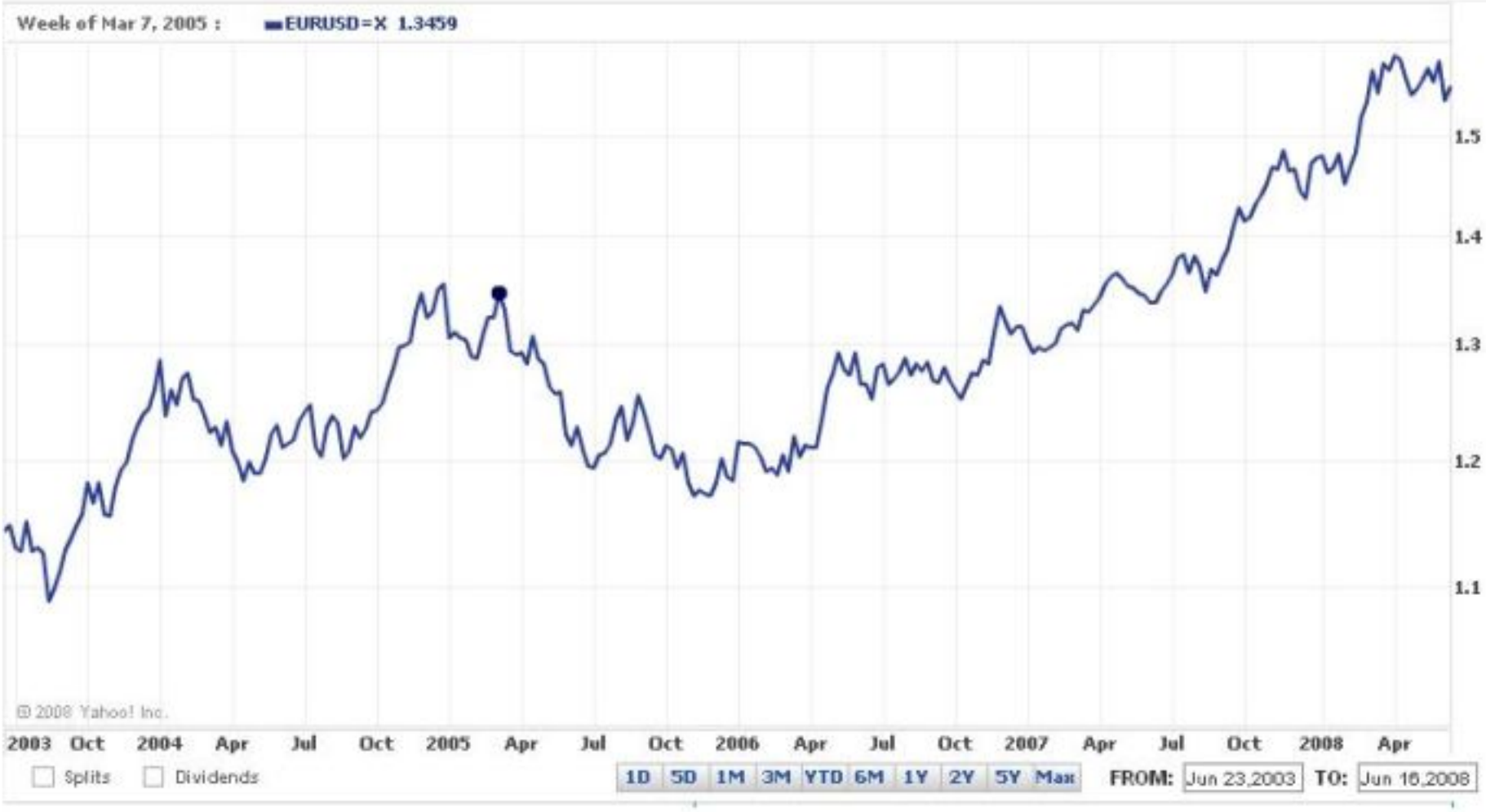
23 june 2008

Auke van Balen

FEI COMPANY™

TOOLS FOR NANOTECH

Happy to be here despite…



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Topics to discuss

- Remote microscopy scenarios
  - Remote observation
  - Remote operation
  - Remote experiments
  - Portal for experiments
- Titan system architecture
- The Condor project
- TEAM stage integration
- How to proceed from here
  - Who does what when
- wvttk

We did think of it (start of Tecnai, 1992)

I&E ONTWIKKELING E.O. datum: 23-03-1992 DSX 6-4-7439 AT-1

6. The ergonomics of the user interface on the platform, in terms of pa layout and screen layout, shall be a primary concern.
The reaction speed of the instrument, via the user interface and thr remote control, shall be a primary concern.

7. Remote control and remote diagnosis shall be an essential part of th instrument.

8. The platform shall allow adaptation and tuning of the instrument's software by advanced users. These adaptations shall be possible on t instrument itself.

9. The platform shall allow updating the software of instruments in the field to be a low cost operation.

10. The platform shall allow extension of the instrument's capabilities automated functions like autofocus, autostigmator.

Remote microscopy scenarios

Scenario 1: Remote observation

- Operator at the microscope
- Observator(s) at a distance

- Critical: get screen content at the other site
- No problem with response time
- Operator knows how to do it

Remote microscopy scenarios

Scenario 2: Remote operation

- Operator at the remote site
- Full set of control pads and mouse/keyboard provided
- Observators local or remote

- Critical: get screen content at the other site
- Response time due to network can be an issue
- Is all information available at the remote site?
- Remote operator knowledge of the instrument

Remote microscopy scenarios

Scenario 3: Remote experiments

- Experiment runs at instrument, operator observers from a distance
- Intelligence on the instrument side
- Instrument must be autonomous as possible
- How to handle exceptions?
- Example: TEM/STEM tomography data acquisition
  - Most effort in ensuring correct operation at all times

Remote microscopy scenarios

Portal for experiments

- Remote experimentation requires a central place for administration, granting privileges, controlling access, datastorage etc
- Communication facilties: voice/messaging/shared whiteboard/shared files
- Security in terms of “who can do what when” **always** important
- That is where Collaboratory comes in

Remote microscopy critical points

Screen content transport

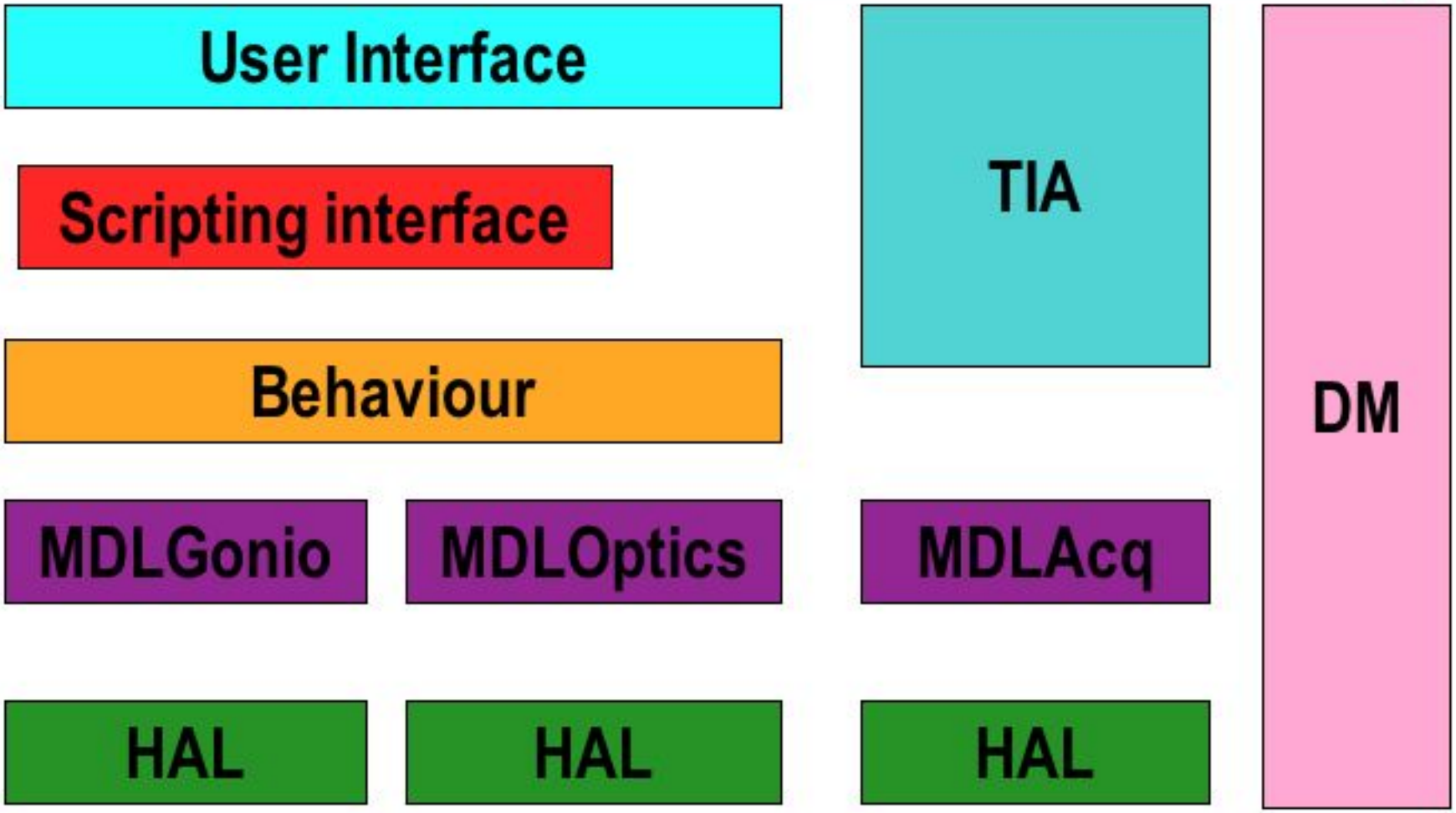
- Grabbing (VNC, Remote Desktop, hw box)
- Display

Network bandwidth and –latency

Difference between local and remote GUI

- Don't try to make just another GUI
  If you would like to build GUIs for microscopes, join FEI

Titan system architecture



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Titan scripting interface

Provides access to most used functions

- Gun/Stage/Optics/Gonio
- Acquisition (as of Titan 1.0) CCD and STEM
- Not to monochromator, correctors as these are not present on all systems
- Every imodule in Tecnai & Titan has a well-defined interface
- Can be made available but creates maintenance/upgrade problem
- We are moving to an Object Model for the complete system

The Condor project

Electron microscopes: Precision Critical Instruments

At the edge of technology

- At the edge of manufacturing reproducibility

Cross-disciplinary designs

- Improvements mostly in combinations of multiple disciplines
  e.g. required positioning precision only achievable by
  beam + stage + control + software
- Mutual understanding essential

Relatively unpredictable operational behavior

- Drift, hysteresis, …
- Behavior influenced by environment

The Condor project

A systems architecture design approach for precision critical instruments

- Based on cross-disciplinary modeling
- Incorporating "Virtual" sub-systems
  - Overcome the limitations caused by sub-system boundaries
- Based on explicit (modeled) knowledge
  - System behavior
  - Limitations
  - Implementation consequences
- Dealing with "uncertainty"
  - Environment cannot be modeled completely
  - Implementations cannot be described precisely
  - Striving for robust behavior

Condor partners

- Embedded Systems Institute, Eindhoven, the Netherlands
- FEI: Carrying Industrial Partner
- University of Antwerp: EMAT
- University of Eindhoven
  - Department of Mathermatics
  - Department of Mechanical Engineering
  - Department of Electrical Engineering
- University of Delft
  - Control Systems Engineering
- University of Leuven
  - Software Engineering
- Technolution (hw/sw consultancy)

Condor details

- February 1st 2008 – January 31st 2012
- 23 fte per year
- 6 PhD students, 5 Postdoc's
- Project management: ESI
- Funding by the dutch Ministry of Economic Affairs
- See www.esi.n/projects/Condor

This will keep me busy until retirement

TEAM stage integration

Just some ideas, to get started

- Control on separate PC
- Goal: easy operation, not full integration

How to proceed

Who does what when